

D \emptyset at Run 2 of the Tevatron

-Status and Prospects -

SUSY02, Hamburg

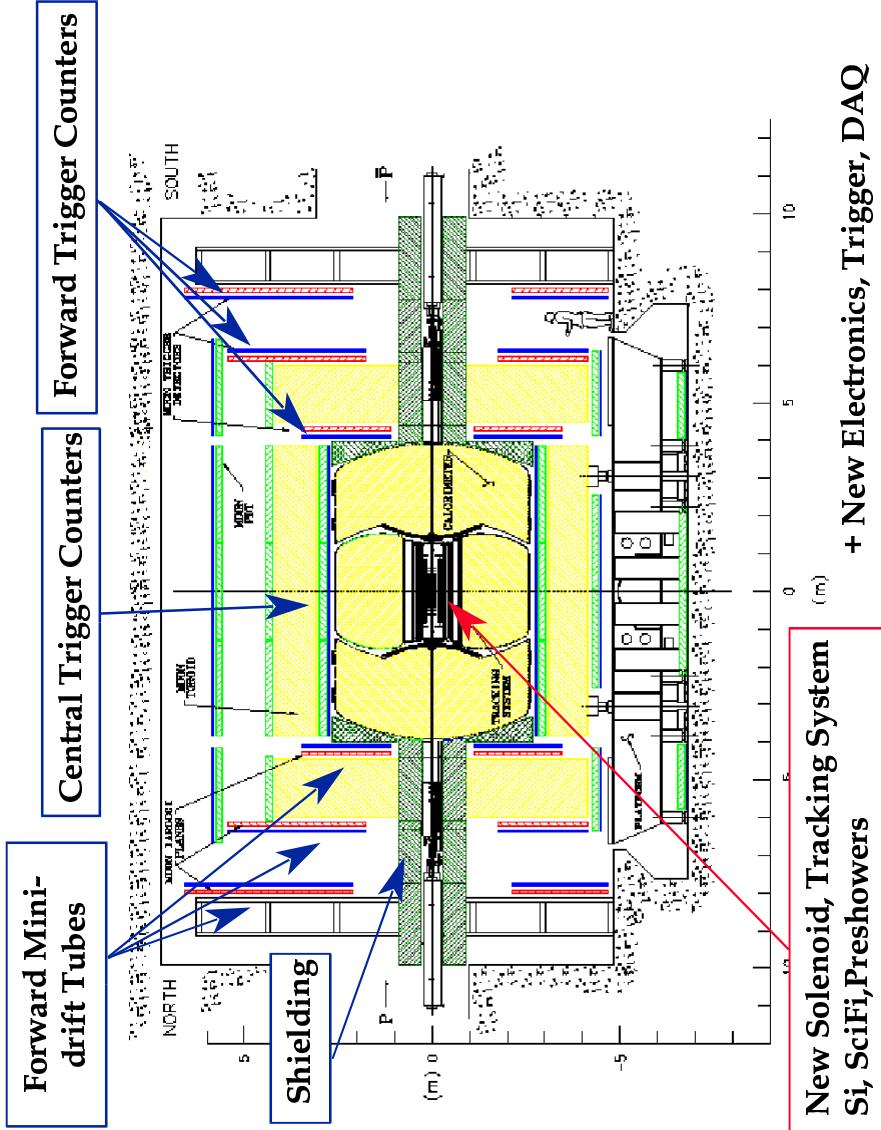
Martin Wegener, RWTH Aachen



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- A circular diagram representing a particle collision at the Tevatron. It features a central yellow and orange radiation pattern, surrounded by concentric rings of red and pink. The outermost ring is light blue. Two grey lines representing particle trajectories enter from the left and right, and they collide at the center. The text "The D \emptyset detector for Run 2" is written in green across the top of the diagram.
- The D \emptyset detector for Run 2
 - Production of SUSY particles at the Tevatron
 - Three examples of SUSY channels at D \emptyset :
 - 3-leptons + E_T
 - Jets+ E_T
 - $\gamma\gamma+E_T$
 - Conclusions

The DØ Experiment in Run 2a

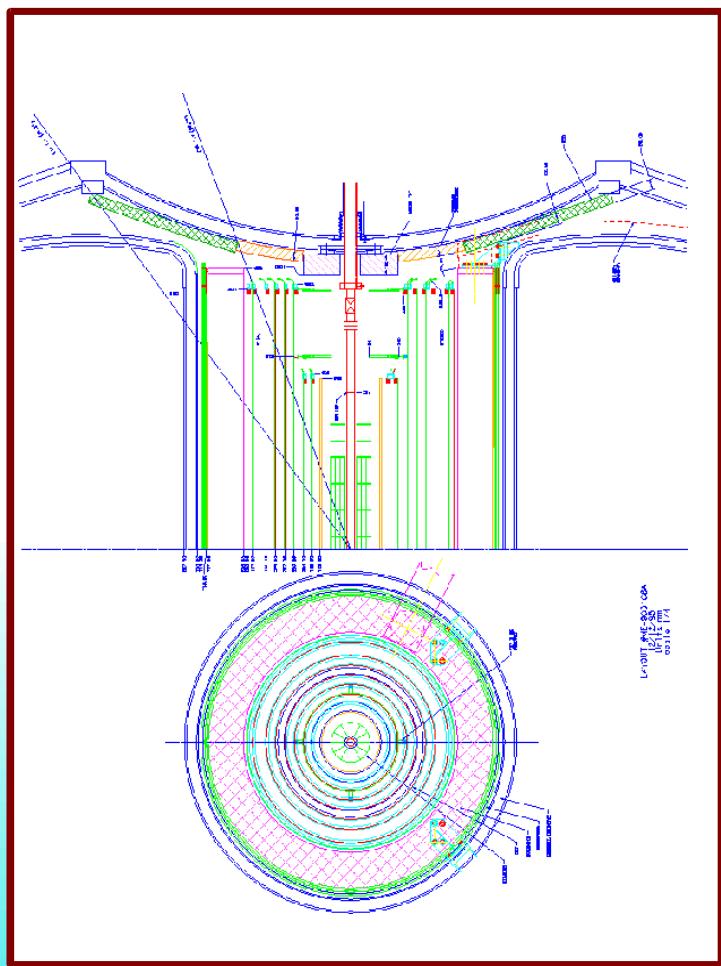
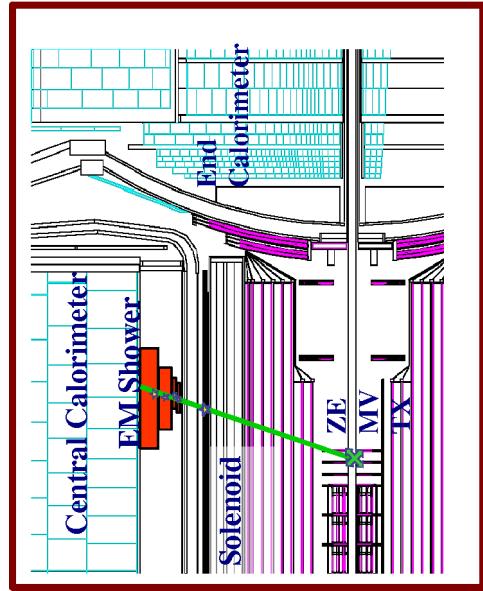
- CM energy
**1.96 TeV vs.
1.8 TeV in Run 1**
- **Run 2a: $\mathcal{L}=2\text{fb}^{-1}$**
(so far delivered: 45 pb^{-1})
- **Run 2b: $\mathcal{L}=15\text{fb}^{-1}$**
- **Upgraded DØ
detector**



DØ Detector Upgrade



- Tracker
 - New 2T Solenoid
 - Proportional Chamber replaced by:
 - ★ Silicon Microvertex Detector
 - ★ Scintillating Fiber Tracker

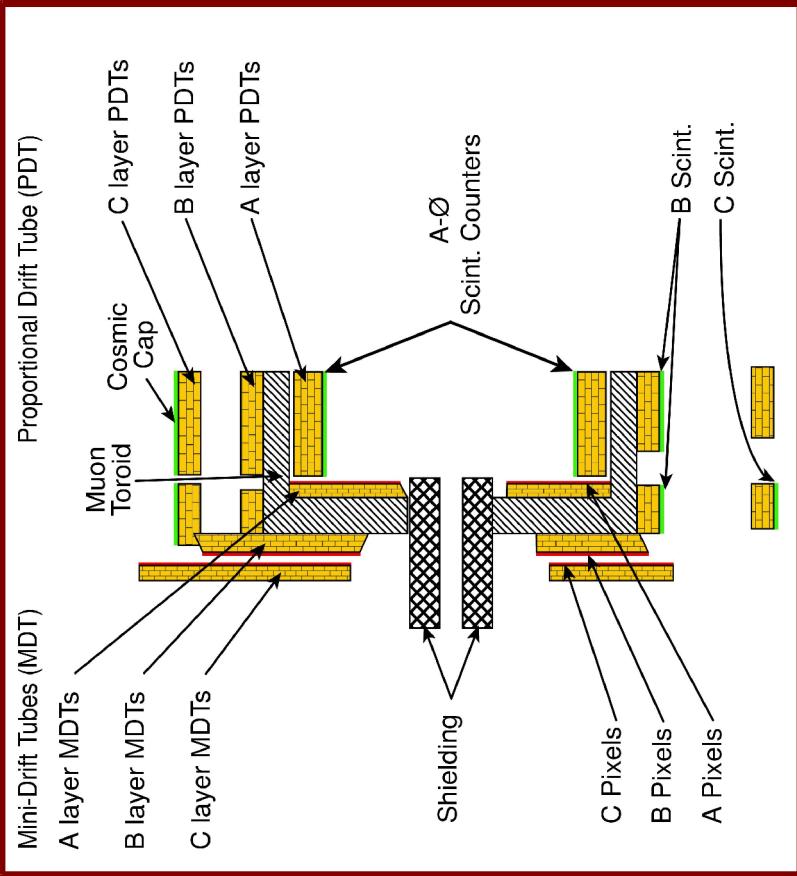


- Central Preshower Detector
 - Will allow precise determination of shower axis
 - Still in commissioning

DØ Detector Upgrade (2)



- **Muon System:**
 - ◆ Proportional Drift Tubes in Forward region replaced by "Mini Drift Tubes" (larocci Tubes)
 - ◆ 3 layers of Pixel Scintillators added in Forward region for η -coverage up to 2.0
 - ◆ Scintillator coverage completed in central region

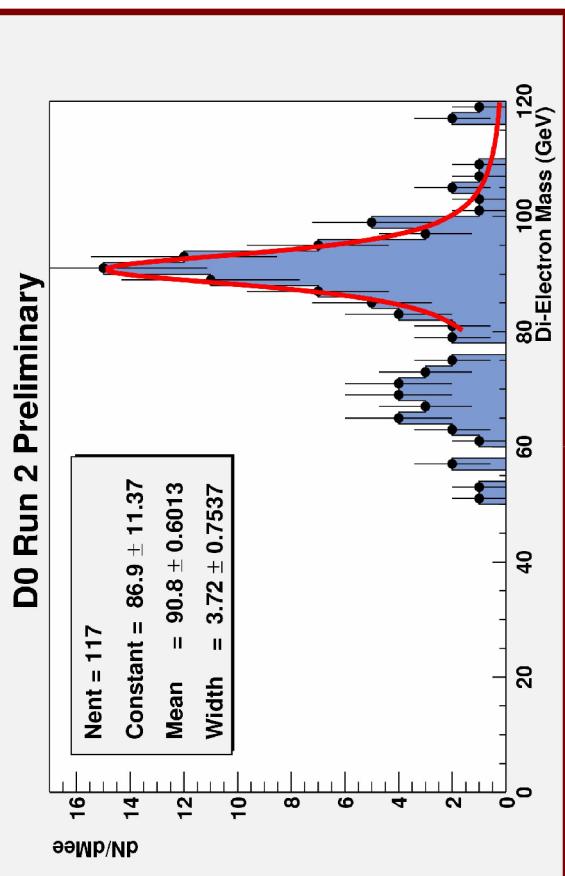
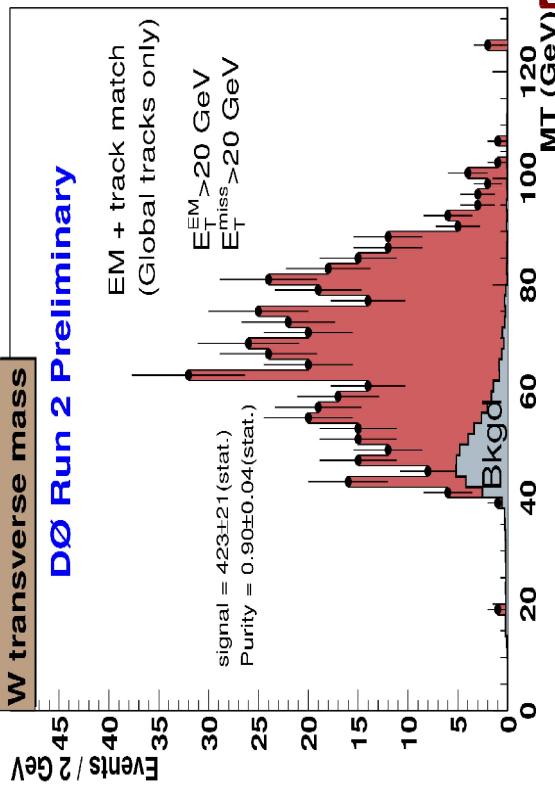


- **New Calorimeter Electronics**
- **Completely new 3-level Trigger System**

Detector Performance: EM Objects



- EM objects w/ match to “global” (silicon+fiber) track
- $E_T^{\text{EM}} > 20 \text{ GeV}$
- $E_T > 20 \text{ GeV}$

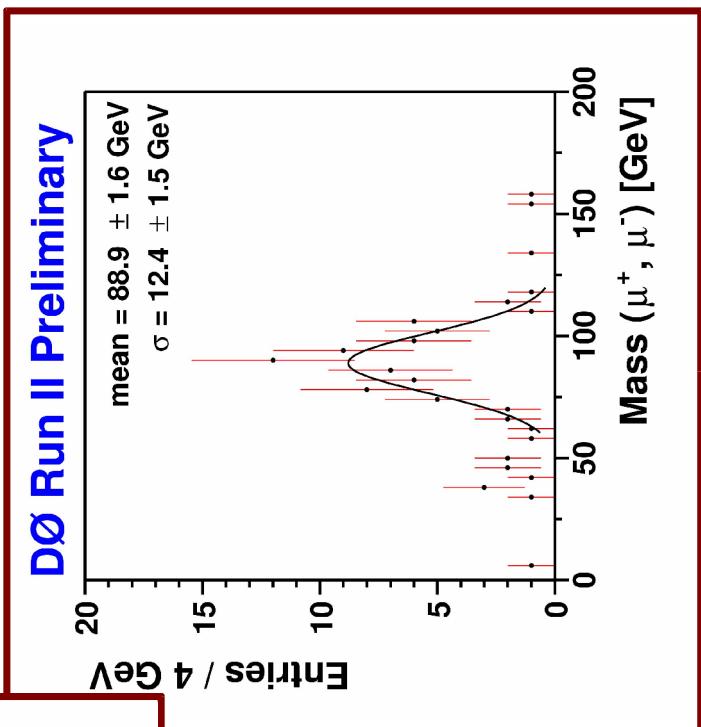
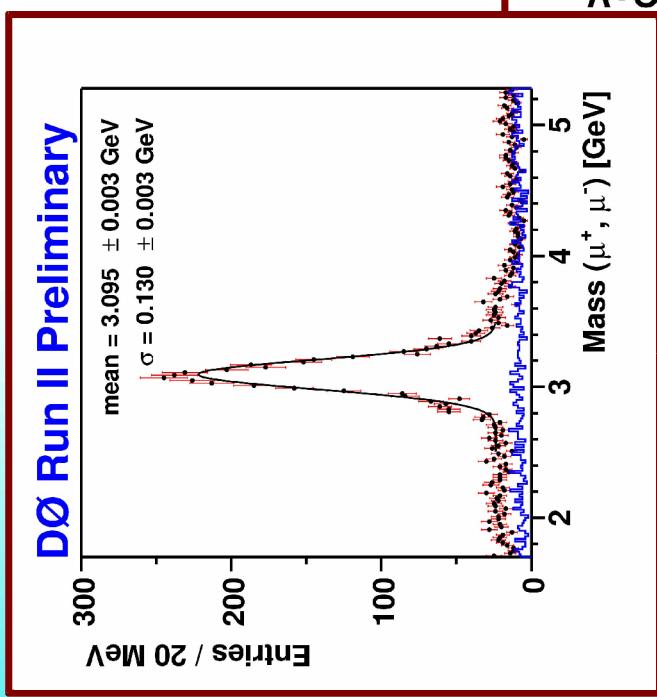


- 10 pb^{-1} of data
- **Cuts:** Standard DØ EM-ID
 - $E_T > 20 \text{ GeV}$
 - $E_T < 30 \text{ GeV}$
 - $|\eta| < 1.1 \text{ or } 1.5 < |\eta| < 2.5$
- $N_Z = 117$
- $m_Z = 90.8 \pm 0.6 \text{ GeV}$
- $\sigma = 3.72 \pm 0.75 \text{ GeV}$

Detector Performance: Muons



- **J/ Ψ and Z peak are clearly visible in Di-muon mass plots**



- **Central tracking allows significant improvement of momentum resolution wrt. Run1**



production cross sections for sparticles

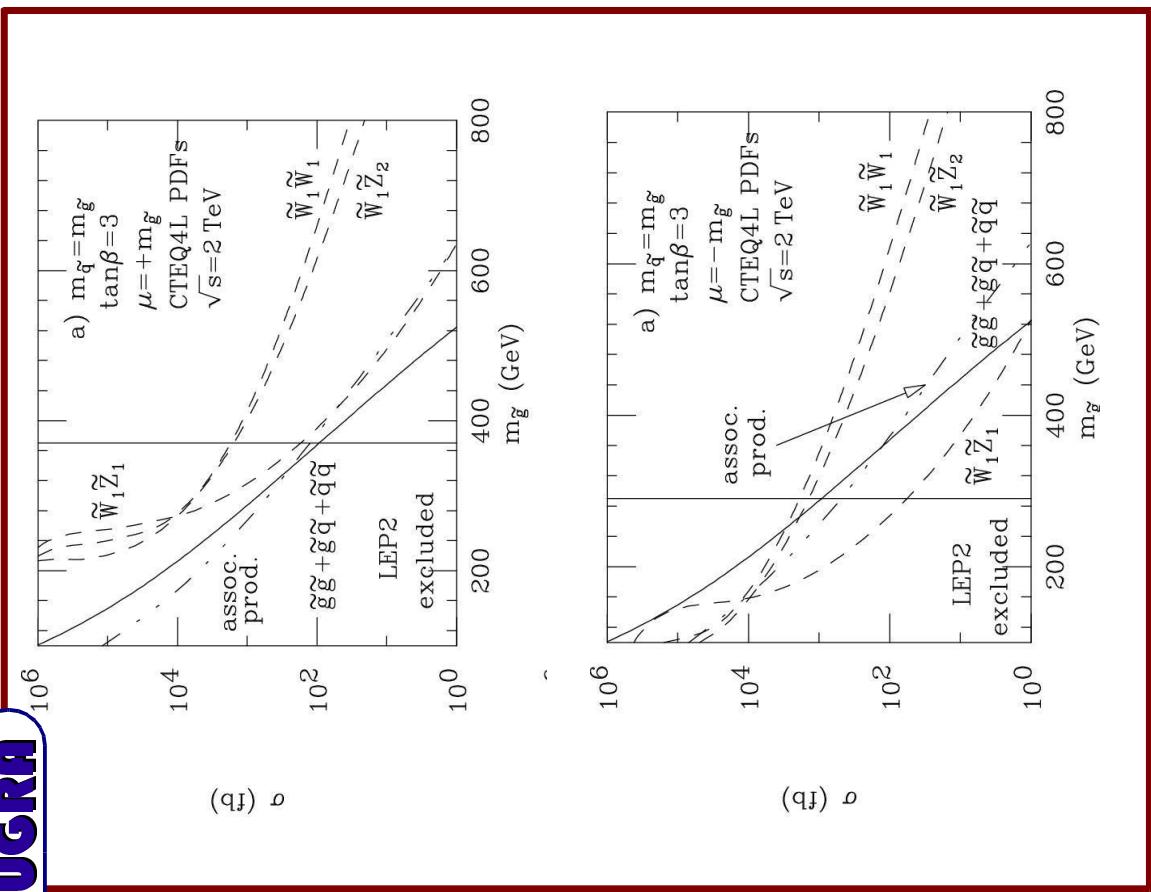
msugra

- Assumption: $|\mu| \gg M_1, M_2$

$\Rightarrow \chi_1^0, \chi_2^0, \chi_1^\pm$ are gaugino-like

- For most regions of the parameter space χ_1^0/χ_1^\pm production dominates

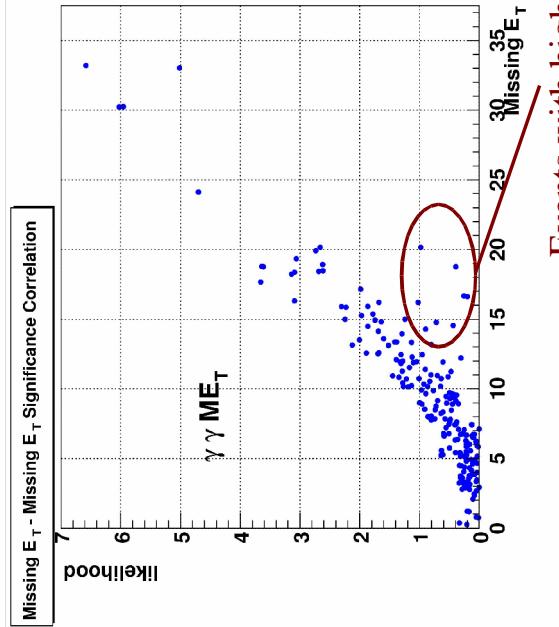
- Slepton/sneutrino production becomes relevant for small m_0



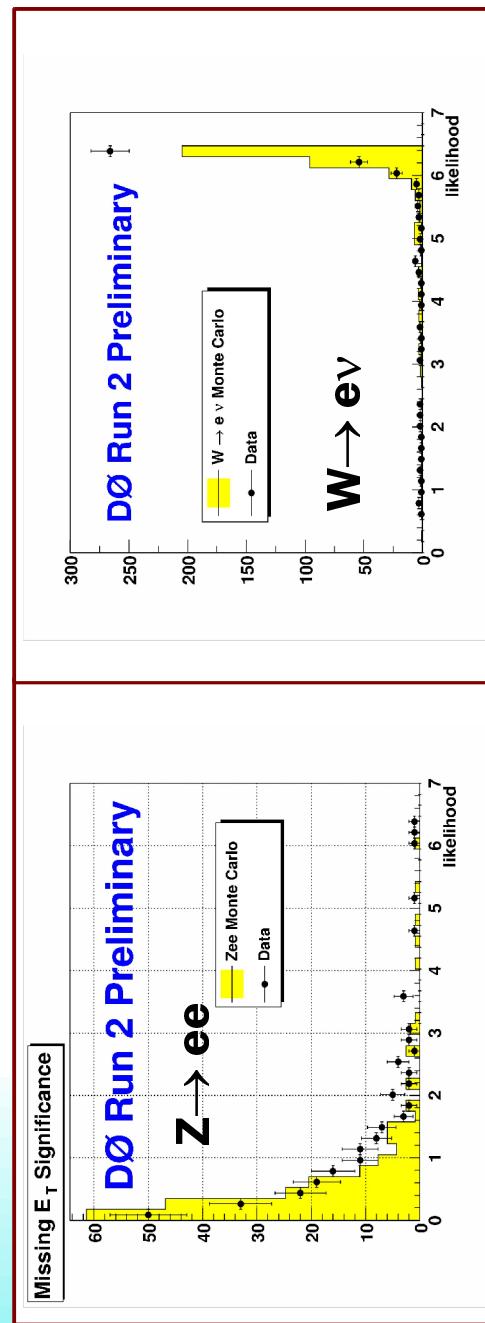


Likelihood method to identify E_T

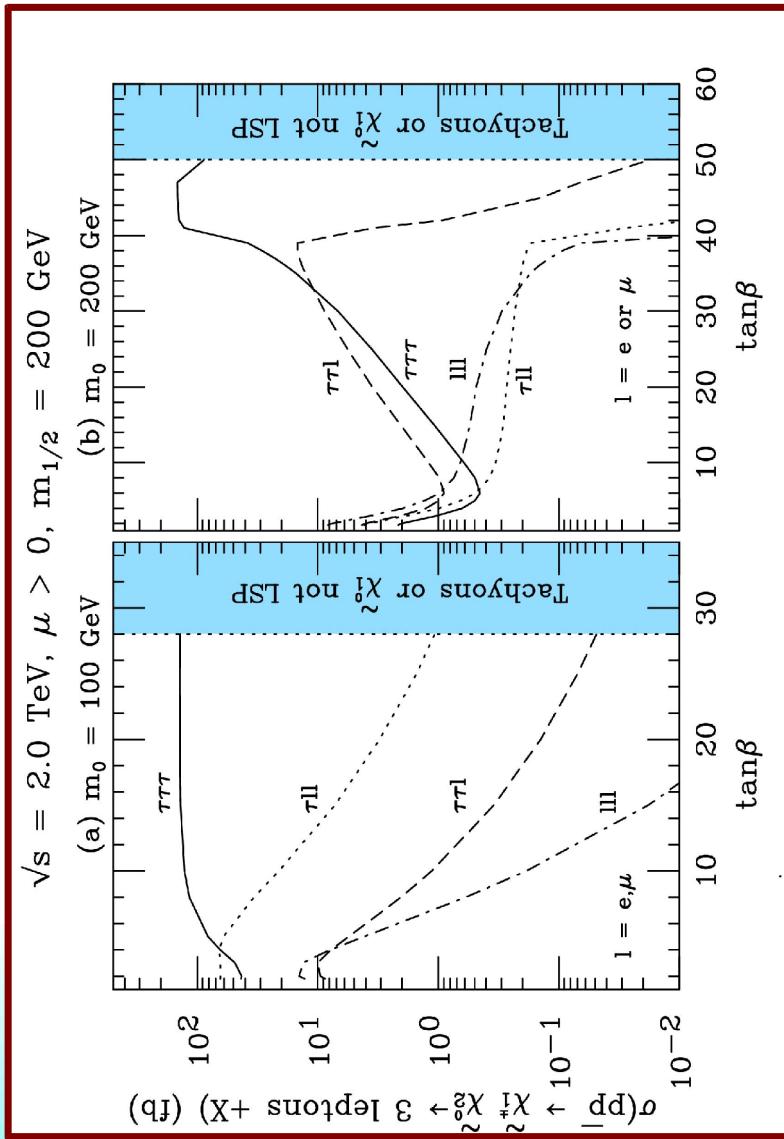
- Aim: Discern "true" and "fake" E_T
- Idea: Measure E_T resolution of an event by considering
 - misvertexing
 - energy resolution of measured physics objects
 - hot cells
 - etc.
- Compute a Likelihood discriminant



Events with high E_T but low likelihood can be discriminated



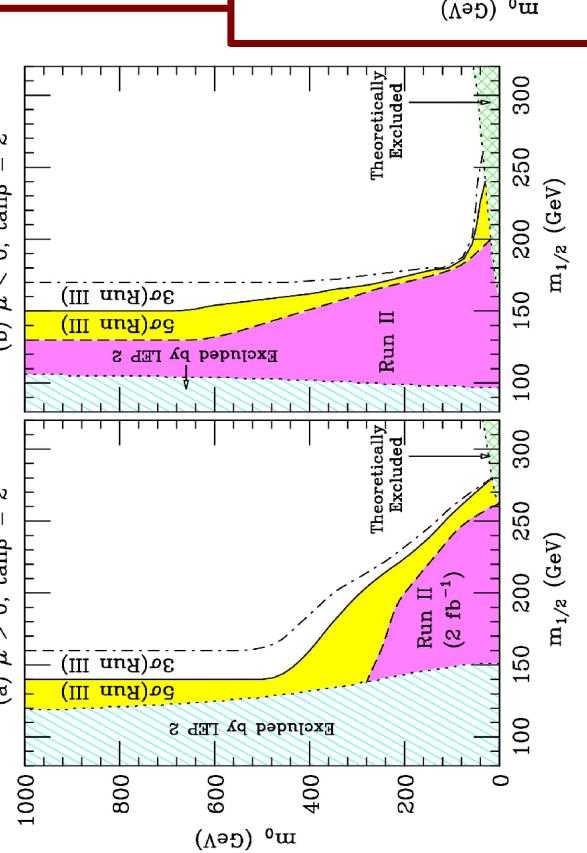
Tri-leptons: Cross Sections



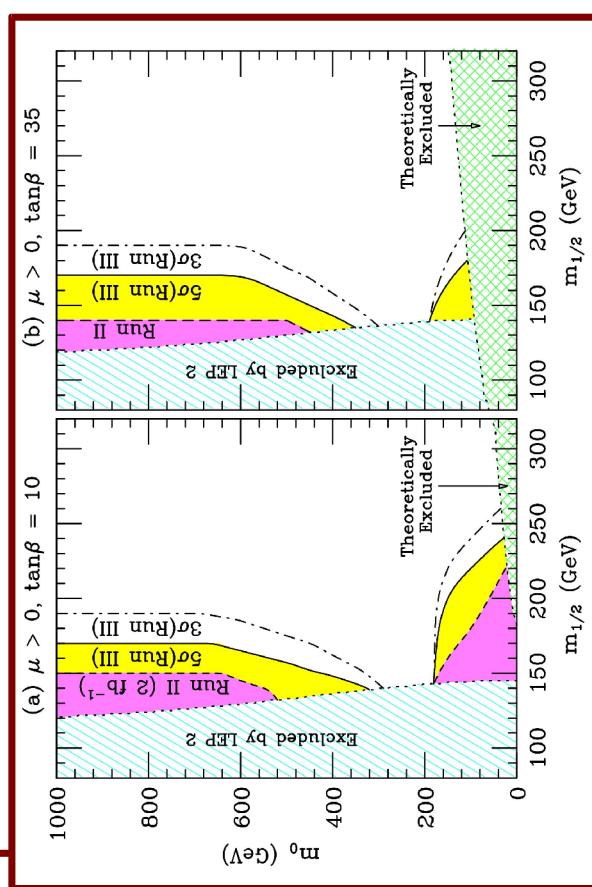
- For low $\tan\beta$ 3-lepton (e/μ) cross-section between 0.1 and 10 fb
- Search for two like-sign leptons is an alternative:
- Enhanced sensitivity, background still under control
- For large $\tan\beta$ τ identification becomes important

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Tri-leptons: Accessible regions



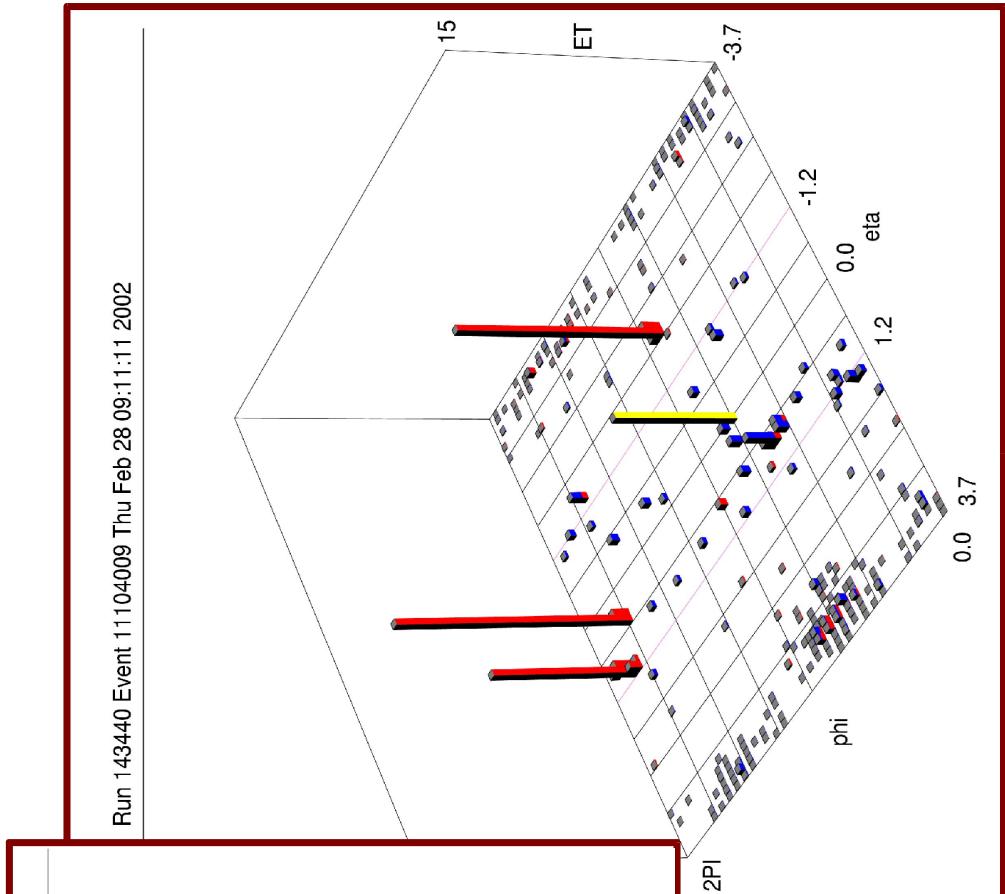
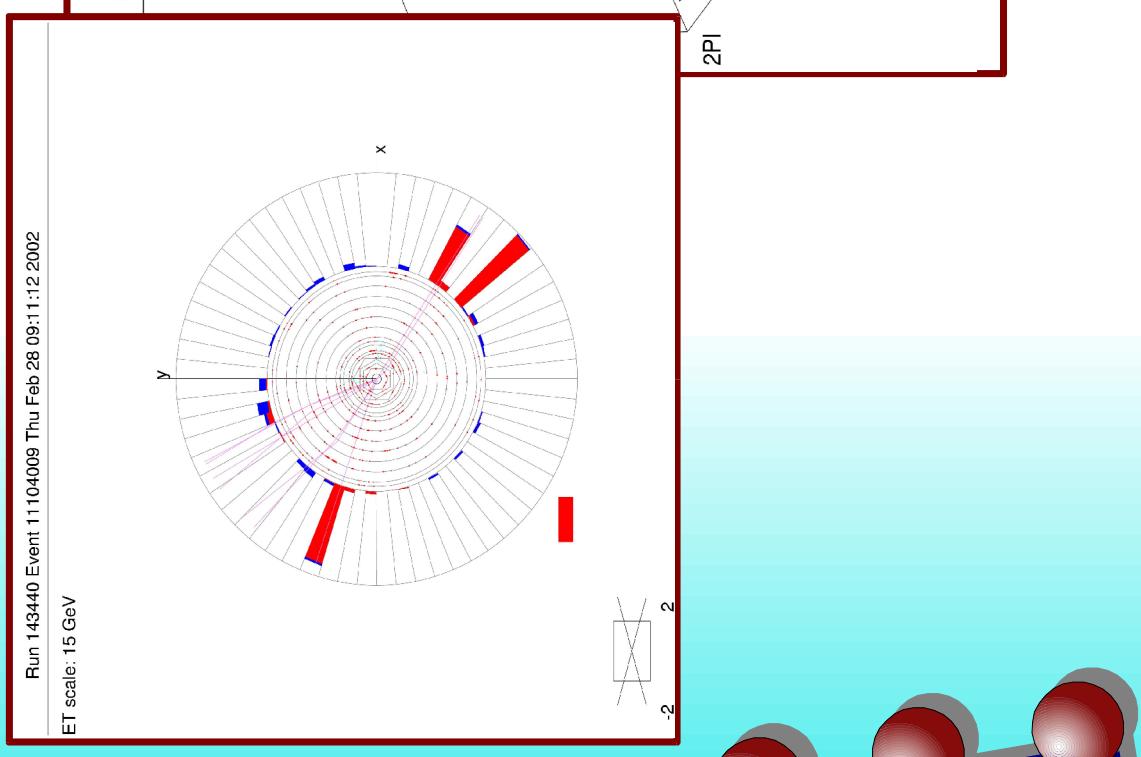
purple: 5σ significance w/ 2 fb^{-1} (Run2a)
yellow: 5σ significance w/ 25 fb^{-1} (Run2b)
dashed: 3σ significance w/ 25 fb^{-1}



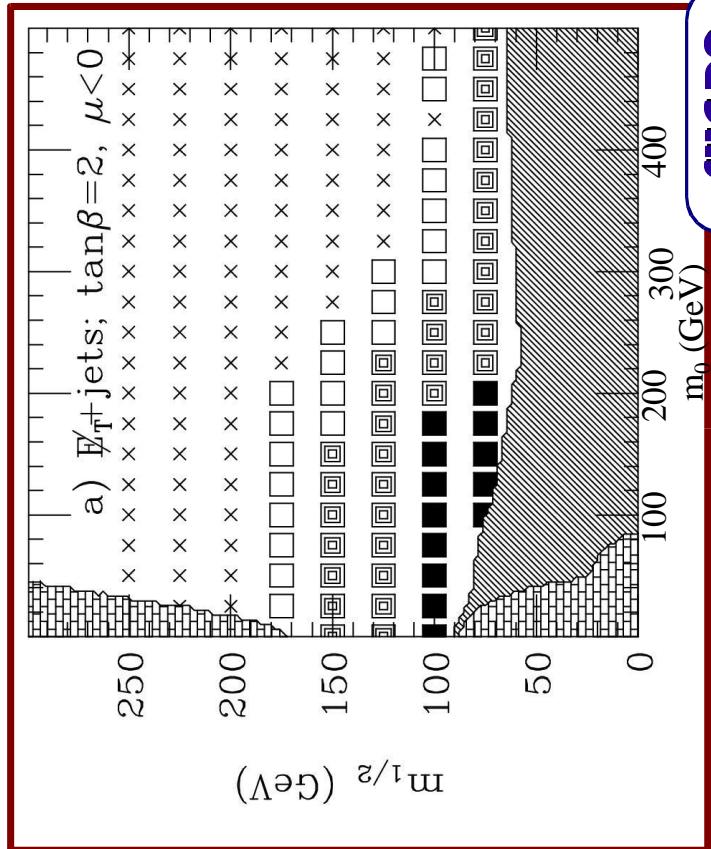
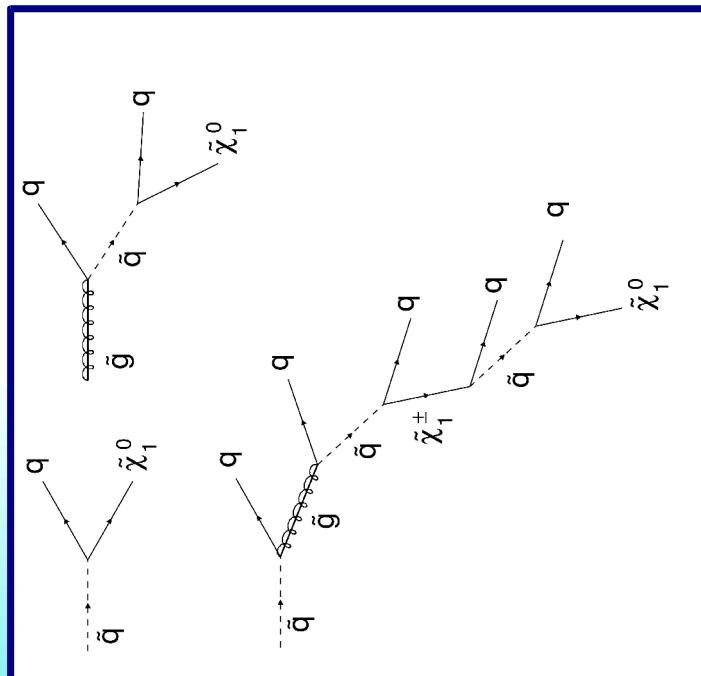
- $\chi^{\pm}_1 \chi^0_2 \rightarrow 3l$ is one of the most promising channels for SUSY discovery at D0
- Run 2a and Run 2b will be able to cover significant regions of the m_0 - $m_{1/2}$ parameter space

mSUGRA

Tri-leptons: $e\bar{e} + \bar{E}_T$ candidate



squark & gluino search



- **Cascades with squarks/gluinos/charmonos possible**
- **Searching for signature: n jets + missing \cancel{E}_T**

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- **gluino search: Multijet + \cancel{E}_T observable regions (5σ significance)**
 - black squares: 0.1 fb^{-1} (Run 1)
 - grey squares: 2 fb^{-1} (Run 2)
 - white squares: 25 fb^{-1} (Run 2b)

• **D0 should be able to probe $m_{1/2}$ up to 150 GeV , corresponding to $m_g \approx 400 \text{ GeV}$, if $m_0 < 200 \text{ GeV}$.**

Jets + \cancel{E}_T



- **Trigger**
 - Use central jet trigger requiring **4 Trigger Towers above 5 GeV** (\cancel{E}_T trigger not yet available)
 - Require $E_{jet} > 60$ GeV to ensure **100% trigger efficiency**
- **Cuts**
 - **2 central jets**
 - **No jet w/ $p_T > 20$ GeV in "weak" detector regions:**
 $0.9 < |\eta| < 1.5$ or $|\eta| > 2.5$
 - **No jet w/ $p_T > 25$ GeV (anti)parallel to \cancel{E}_T .**
 - **Veto on Electrons and Muons**

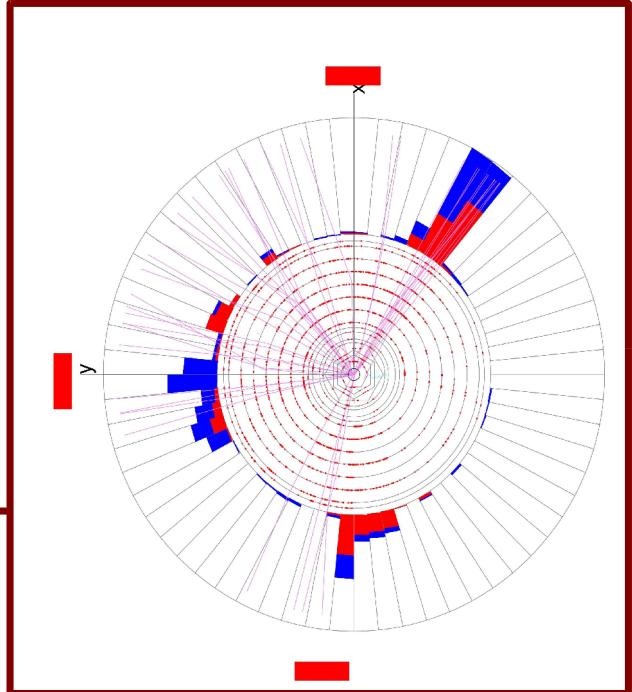
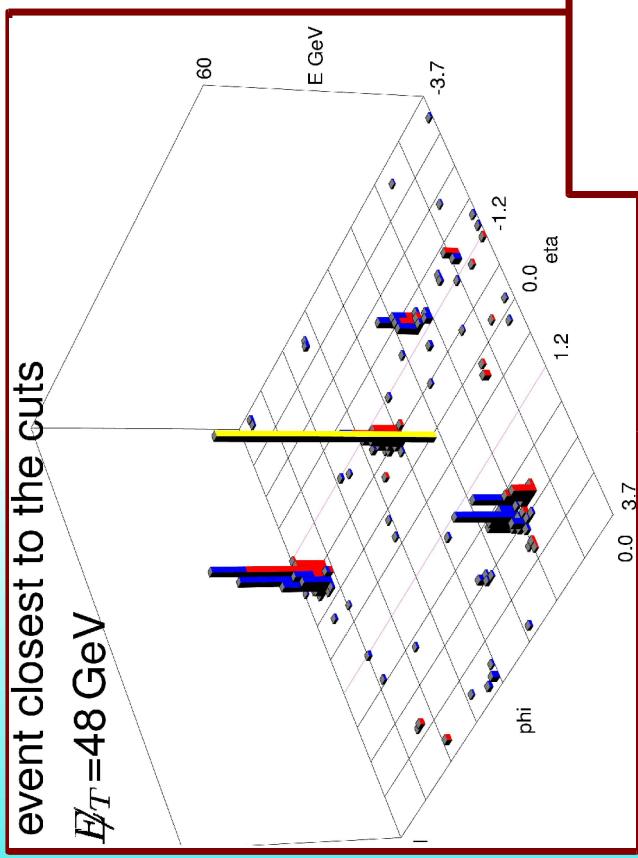
- **Optimisation for 2 mSUGRA points:**

$(m_0, m_{1/2})/GeV$	(100,100)	(500,70)
p_T^{jell}	90 GeV	60 GeV
H_T	60 GeV	70 GeV
E_T	80 GeV	50 GeV

Jets + \cancel{E}_T (2)

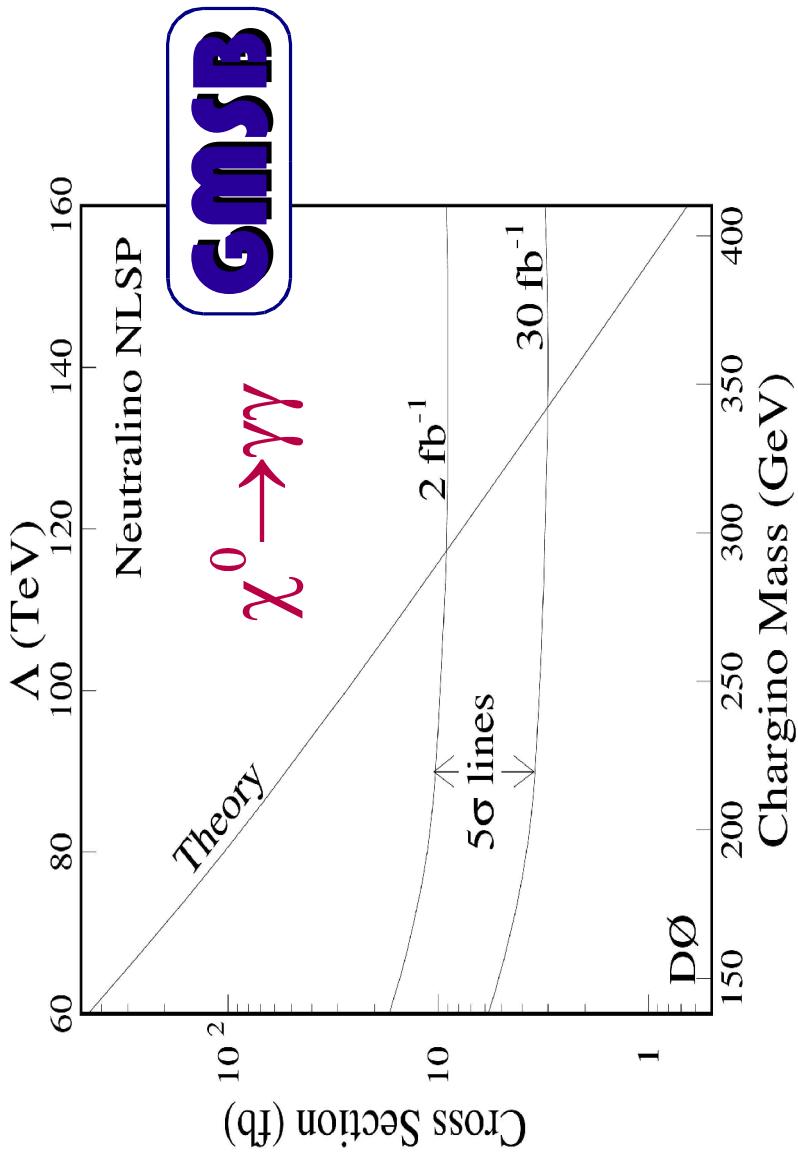


- event closest to the cuts
 $\cancel{E}_T = 48 \text{ GeV}$
- Integrated Luminosity
 $\mathcal{L} = 0.75 \text{ pb}^{-1}$ (Feb 2002)
- 0.09 events expected
0 events found



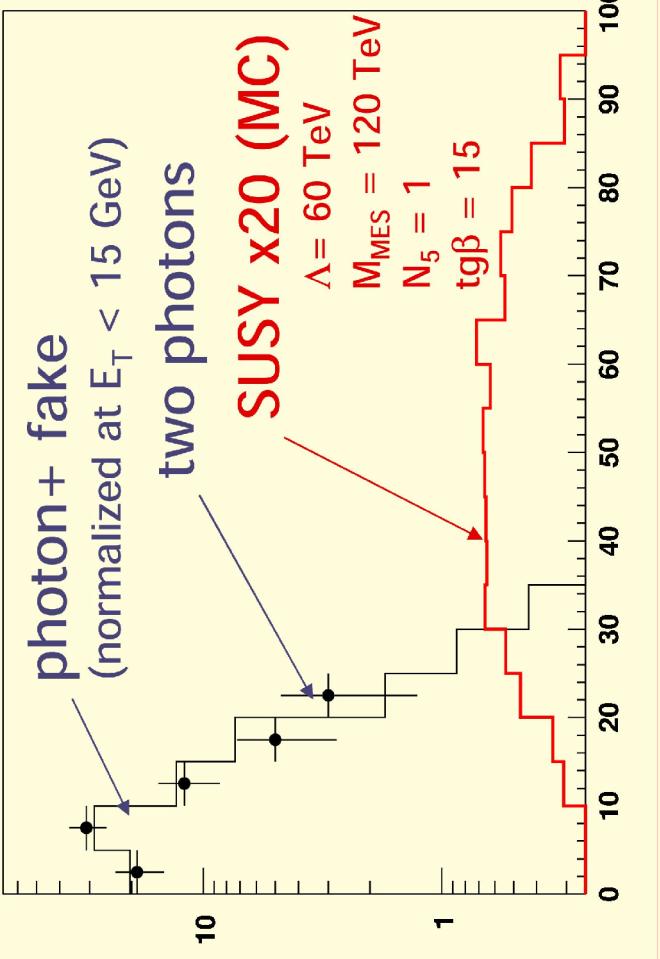
$\gamma\gamma + \cancel{E}_T$: Cross sections

- In most gauge-mediated SUSY models the gravitino is the LSP
- If the next to lightest SP is a bino-like neutralino, it will dominantly decay into two photons



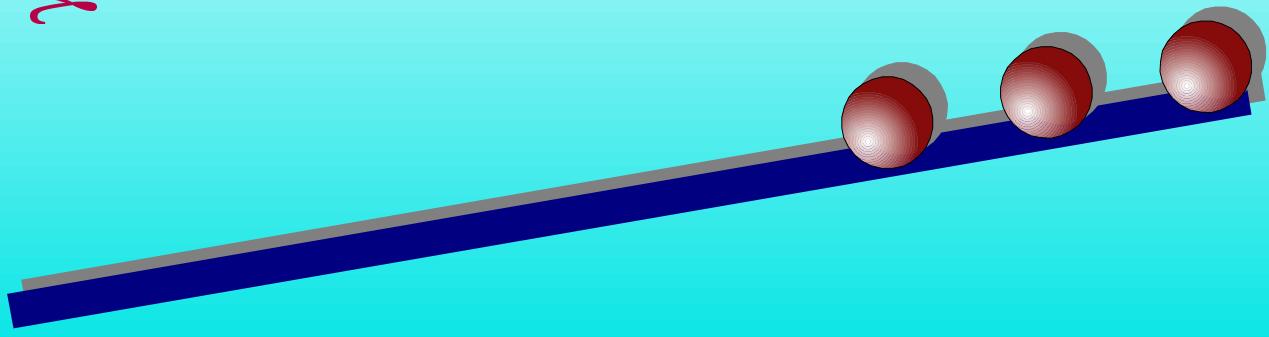
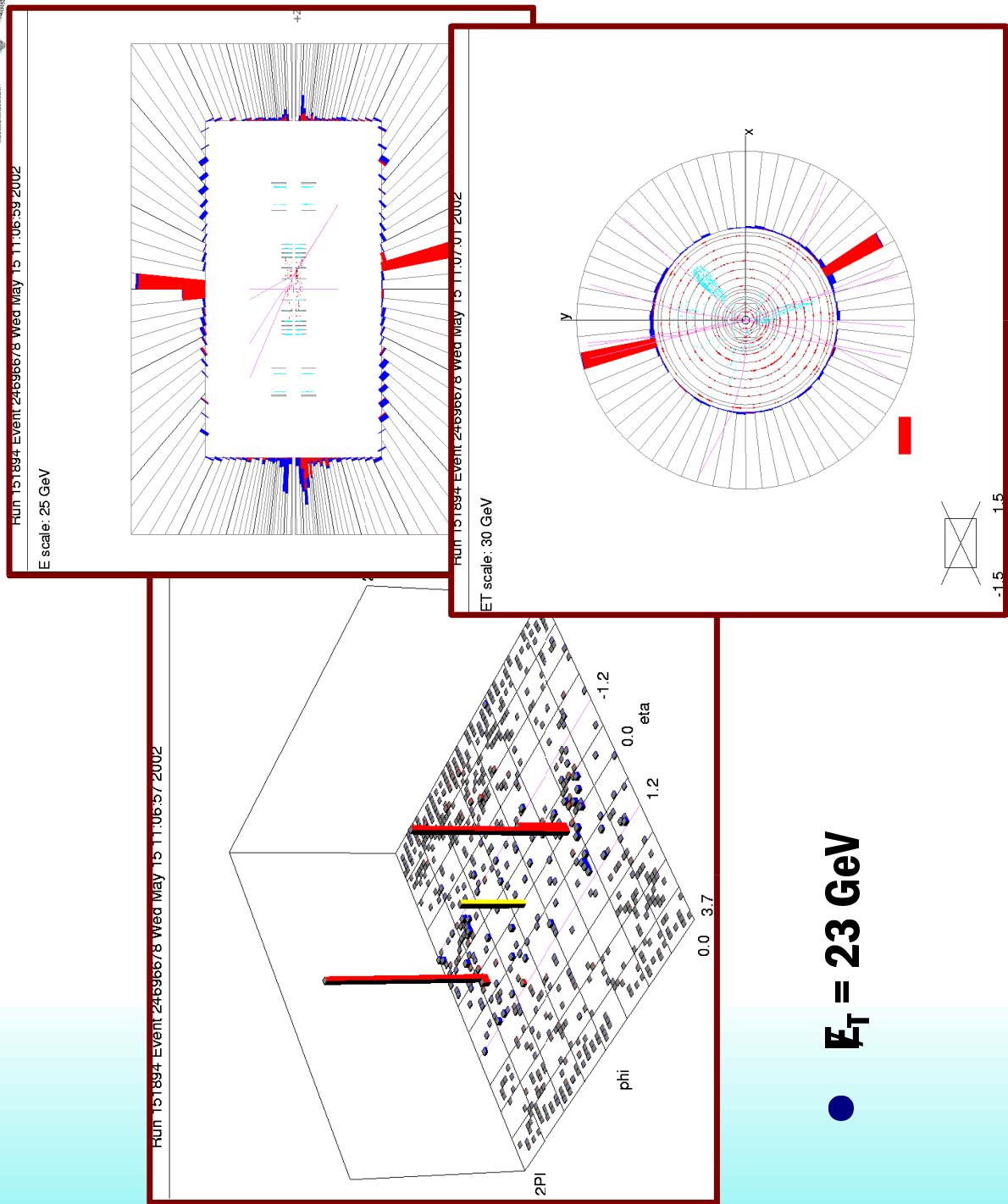
- Comparison of theoretical cross sections and 5σ discovery cross sections for $\mathcal{L} = 2 \text{ fb}^{-1}$ (Run2a) and $\mathcal{L} = 30 \text{ fb}^{-1}$ (Run2b)
- Reach in chargino mass: 290 (340) GeV

$\gamma\gamma + E_T$: Understanding the E_T resolution



- **Aim:** determine distribution of apparent E_T
- **Idea:** Use sample of $\gamma + \text{jet}$, where the jet **fakes** a photon
 - ♦ Virtually no true missing transverse energy
 - ♦ Same energy resolution as $\gamma\gamma$ events
- Compare this distribution to expected SUSY signal

$\gamma\gamma + E_T$: Highest E_T Event



Conclusions

- D \emptyset is operational
- Z, J/ Ψ ,... can be seen in different channels
- A number of analyses to search for SUSY signals is in progress
 - Tri-leptons + E_T
 - Jets + E_T
 - $\gamma\gamma + E_T$
- All important channels should be covered until 2003
- We expect to exceed Run 1 limits this year
- An exciting time is ahead of us - stay tuned...

